



US009086339B2

(12) **United States Patent**  
**Lee et al.**

(10) **Patent No.:** **US 9,086,339 B2**  
(45) **Date of Patent:** **Jul. 21, 2015**

(54) **ELONGATION TESTER**

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**,  
Yongin, Gyeonggi-Do (KR)

(72) Inventors: **In-Nam Lee**, Yongin (KR); **Sung-Ku Kang**, Yongin (KR)

(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**,  
Yongin, Gyeonggi-Do (KR)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 64 days.

(21) Appl. No.: **14/077,257**

(22) Filed: **Nov. 12, 2013**

(65) **Prior Publication Data**

US 2014/0139252 A1 May 22, 2014

(30) **Foreign Application Priority Data**

Nov. 20, 2012 (KR) ..... 10-2012-0131393

(51) **Int. Cl.**

**G01R 31/00** (2006.01)

**G01N 3/08** (2006.01)

**G01R 31/28** (2006.01)

**G01N 3/32** (2006.01)

(52) **U.S. Cl.**

CPC ..... **G01N 3/08** (2013.01); **G01R 31/2893** (2013.01); **G01N 3/32** (2013.01); **G01N 2203/0282** (2013.01); **G01N 2203/0617** (2013.01); **G01R 31/2886** (2013.01)

(58) **Field of Classification Search**

CPC ..... **G01N 3/00**; **G01N 3/08**; **G01N 3/32**; **G01N 2203/0017**; **G01N 2203/0282**; **G01N 2203/0075**; **G01N 2203/0252**; **G01N 2203/0254**; **G01R 1/07378**; **G01R 1/00**; **G01R 1/04**; **G01R 31/2893**; **G01R 31/2886**;

G01R 31/2889; G01R 31/2887; B32B 2307/51; B32B 2038/008; G01B 5/30; G01B 7/16; G01L 1/2206; G01L 5/045; H01L 31/03926; H01L 41/0986  
USPC ..... 324/513, 515, 660, 691, 756.01, 324/756.07, 756.02, 755.11; 160/328-329, 160/354, 378; 140/108; 227/12-13; 254/10.5, 216; 73/796, 826, 811, 830, 73/862.07, 862.392, 862.471, 862.42  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

2,756,590 A \* 7/1956 Gehman et al. .... 73/792  
3,958,455 A \* 5/1976 Russell ..... 73/862.68  
5,600,895 A \* 2/1997 Meyer et al. .... 33/789  
5,712,430 A \* 1/1998 Meyer ..... 73/831  
5,819,428 A \* 10/1998 Meyer ..... 33/787  
6,323,389 B1 \* 11/2001 Thomas et al. .... 604/370  
6,487,902 B1 \* 12/2002 Ghosh ..... 73/159  
6,612,189 B1 \* 9/2003 Miyauchi ..... 73/862.392  
6,688,185 B2 \* 2/2004 Knox et al. .... 73/862.045

(Continued)

**FOREIGN PATENT DOCUMENTS**

KR 10-2007-0121680 A 12/2007  
KR 10-2012-0030309 A 3/2012

*Primary Examiner* — Patrick Assouad

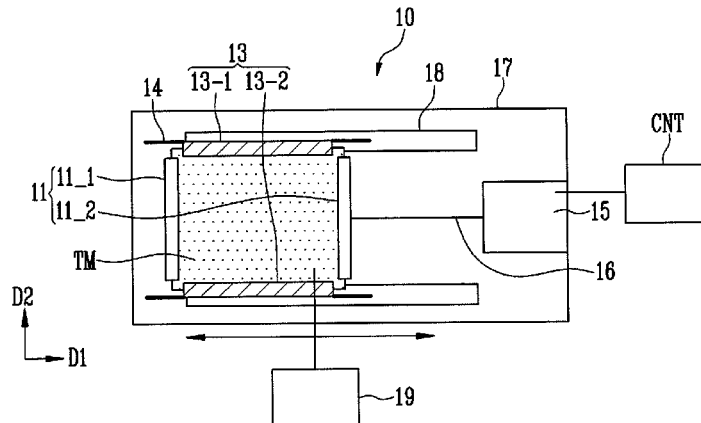
*Assistant Examiner* — Sean Curtis

(74) *Attorney, Agent, or Firm* — Lee & Morse, P.C.

(57) **ABSTRACT**

An elongation tester includes a fixed holder configured to hold an end of a tested material, a variable holder configured to hold a side of the tested material, the variable holder being formed of an elastic material and having a holding region that deforms in a longitudinal direction of the side of the tested material in accordance with deformation of the tested material, and a driver configured to reciprocate the fixed holder.

**11 Claims, 2 Drawing Sheets**



(56)

**References Cited**

## U.S. PATENT DOCUMENTS

6,835,461	B1 *	12/2004	Yamagata et al. ....	428/847.2	2005/0133151	A1 *	6/2005	Maldonado Pacheco et al. ....	156/164
7,677,110	B2 *	3/2010	Perez Blanco et al. ....	73/826	2006/0147685	A1 *	7/2006	Potnis et al. ....	428/212
8,097,926	B2	1/2012	De Graff et al.		2006/0147716	A1 *	7/2006	Braverman et al. ....	428/411.1
8,120,729	B2 *	2/2012	Choi et al. ....	349/96	2006/0148354	A1 *	7/2006	Shelley et al. ....	442/182
8,137,344	B2 *	3/2012	Jia et al. ....	606/45	2009/0020913	A1 *	1/2009	Sakamaki ....	264/291
2004/0258887	A1 *	12/2004	Maciag et al. ....	428/156	2011/0234213	A1 *	9/2011	Stritzke et al. ....	324/238
2004/0261639	A1 *	12/2004	Vaughn et al. ....	101/248	2012/0070615	A1 *	3/2012	Shi et al. ....	428/143
2005/0073071	A1 *	4/2005	Yamazaki et al. ....	264/216	2012/0312585	A1 *	12/2012	Baek et al. ....	174/254
					2014/0127485	A1 *	5/2014	Uto et al. ....	428/212

\* cited by examiner

FIG. 1A

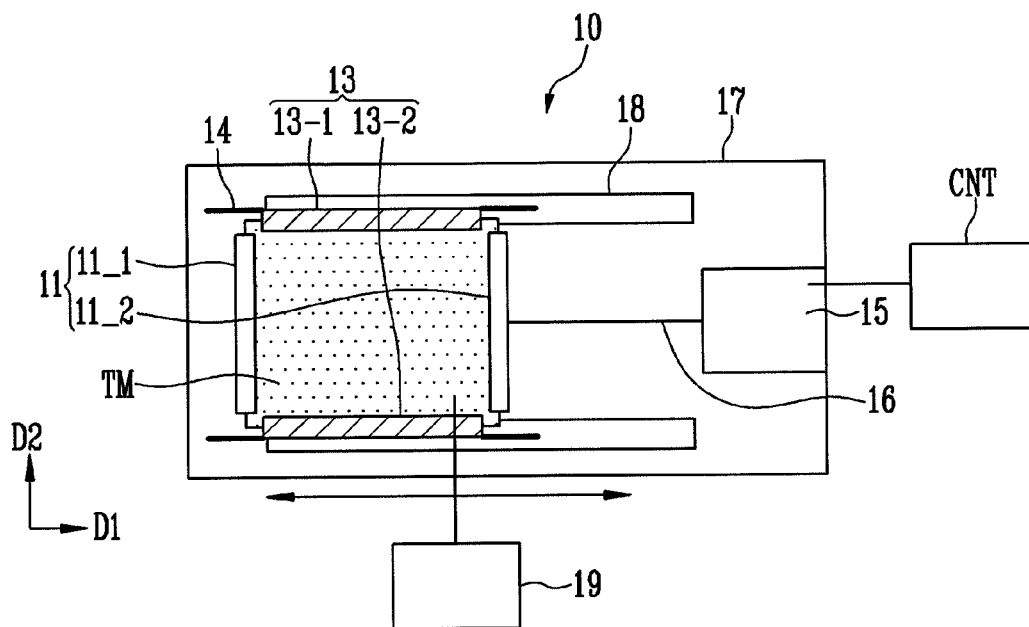


FIG. 1B

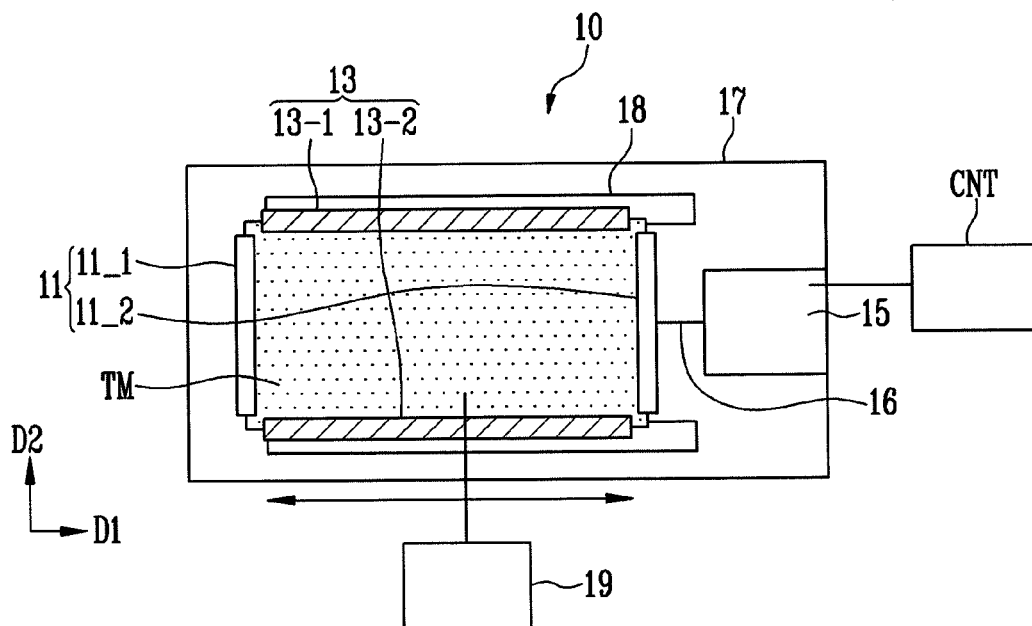


FIG. 2

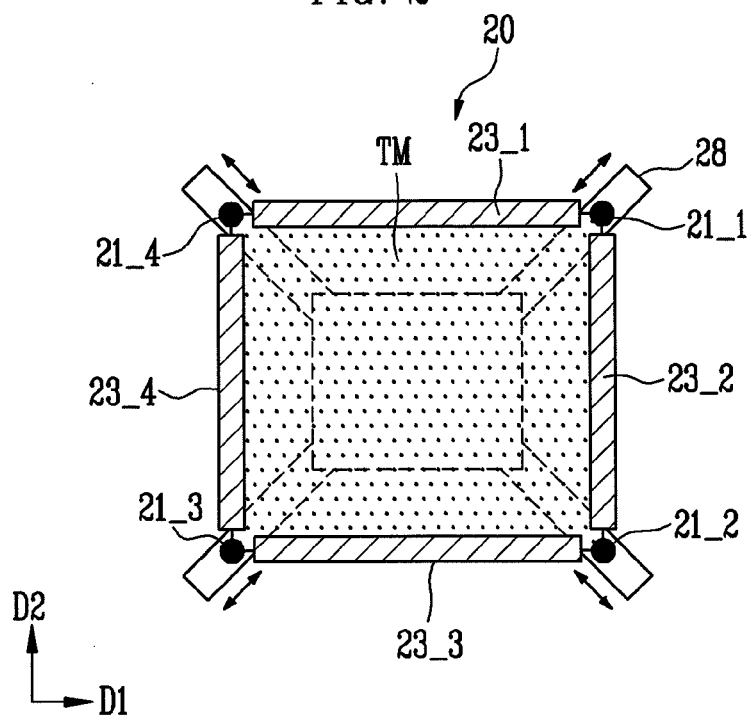
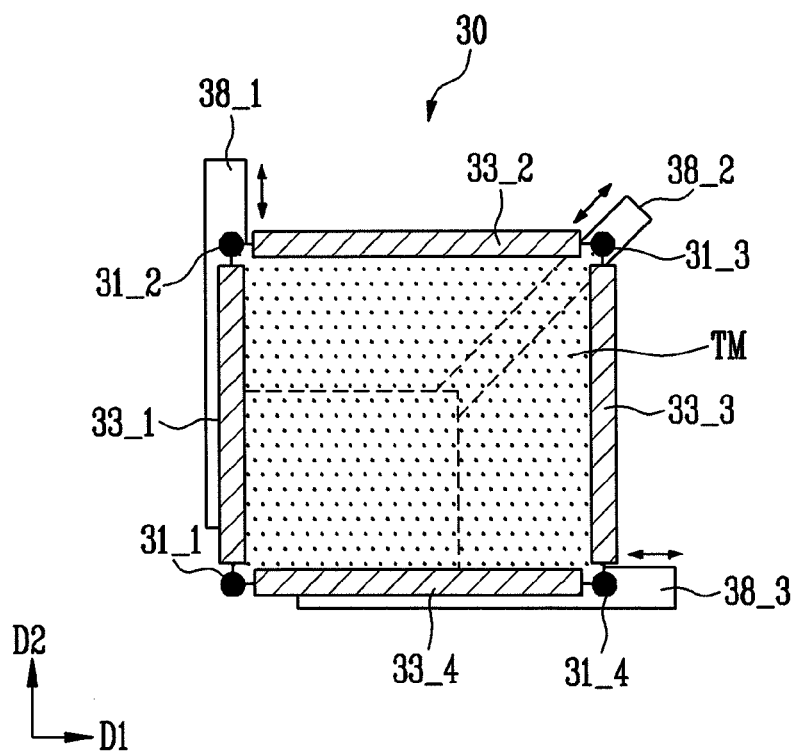


FIG. 3



# 1

## ELONGATION TESTER

### CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2012-0131393, entitled "Elongation Tester" and filed on Nov. 20, 2012, in the Korean Intellectual Property Office, the entire contents of which are incorporated herein by reference in their entirety.

### BACKGROUND

#### 1. Field

Embodiments relate to an elongation tester.

#### 2. Description of the Related Art

A flexible substrate and electrode material that may be freely bent may be used for a flexible display. Due to repeated deformation, the electric characteristic of an electrode may be changed so that the performance of the electrode may be deteriorated.

### SUMMARY

An embodiment is directed to an elongation tester, including a fixed holder configured to hold an end of a tested material, a variable holder configured to hold a side of the tested material, the variable holder being formed of an elastic material and having a holding region that deforms in a longitudinal direction of the side of the tested material in accordance with deformation of the tested material, and a driver configured to reciprocate the fixed holder.

A wire lead may be inserted into the variable holder in the longitudinal direction of the variable holder.

The wire lead may be longer than the variable holder.

A plurality of variable holders may be provided to surround a perimeter of the tested material.

The elongation tester may further include a supporting unit including a guide rail for guiding a reciprocating motion of one or more of the fixed or variable holders.

At least one of the fixed holder and the variable holder may be supported by the supporting unit.

The driver may be configured to reciprocate the fixed holder in different directions.

The elongation tester may further include a resistance measuring unit configured to measuring a change in resistance of the tested material, and a controller for controlling the driver.

The variable holder may be formed of an elastic polymer material.

The tested material may be a flexible electrode including at least one of a metal nanowire and a carbon nanotube.

First and second fixed holders may hold first and second portions of the tested material, and first and second variable holders may hold third and fourth portions of the tested material, the first and second portions being opposite one another, and the third and fourth portions extending between the first and second portions.

### BRIEF DESCRIPTION OF THE DRAWINGS

Features will become apparent to those of skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIGS. 1A and 1B are views schematically illustrating an elongation tester according to an embodiment; and

# 2

FIGS. 2 and 3 are views schematically illustrating an elongation tester according to another embodiment.

### DETAILED DESCRIPTION

FIGS. 1A and 1B are views schematically illustrating an elongation tester according to an embodiment.

Referring to FIGS. 1A and 1B, an elongation tester **10** according to an embodiment includes a fixed holder **11**, a variable holder **13**, and a driver **15**. In addition, the elongation tester **10** may further include a wire lead **14**, a supporting unit **17**, and a guide rail **18**.

The elongation tester **10** according to the present embodiment expands/contracts a tested material TM in a first direction **D1** to test the elongation of the tested material TM.

The tested material TM may be a conductive material having a flexible characteristic and may be, e.g., a touch screen panel or transparent display flexible electrode. The tested material TM may include at least one of a metal nanowire and a carbon nanotube as a composite material in which various materials are mixed.

The tested material TM may be a square that is similar to the shape of a common display panel and that facilitates an elongation test. However, embodiments are not limited to the above, and the tested material TM may have various sizes and shapes in accordance with an elongation direction and the arrangement structure of holders that hold the tested material TM.

The fixed holder **11** holds the end of the tested material TM. In an implementation, a plurality of fixed holders **11** may be provided. The fixed holder **11** may be positioned on one side or at the edge of the tested material TM in the elongation direction.

According to the present embodiment, since the tested material TM is expanded and contracted only in a first direction **D1** and is fixed in a second direction **D2** perpendicular to the first direction **D1**, the fixed holder **11** is mounted on the left/right sides of the tested material TM that run parallel with the second direction **D2**. That is, a first fixed holder **11\_1** holds the left side of the tested material TM and a second fixed holder **11\_2** holds the right side that faces the left side.

The fixed holder **11** may include, e.g., rectangular compression flat plates oriented in the second direction **D2** along one side of the tested material TM, and may have a structure in which the tested material TM is inserted between the compression flat plates that face each other and the compression flat plates are compressed to fix the tested material TM.

In various implementations, the compression flat plates may be combined with each other by, e.g., fastening members (not shown) such as a bolt/a nut, a joint, and/or a clamp to maintain combination strength.

The fixed holder **11** may be formed of metal or plastic having high strength and durability in order to prevent the tested material TM from being deformed and to perform a reciprocating motion tens of thousands of times.

The size, shape, and structure of the fixed holder **11** may be suitably varied. The fixed holder **11** may be attached to and detached from the elongation tester **10** to be exchanged as occasion demands.

The variable holder **13** holds the outside of the tested material TM. The variable holder may be elastically deformable, and may be formed of an elastic material having a holding region that is configured to deform in the longitudinal direction of the outside of the tested material TM in accordance with the deformation of the tested material TM.

According to the present embodiment, since the tested material TM is expanded and contracted only in the first

3

direction D1, the variable holder **13** is mounted on the top/bottom sides of the tested material TM that run parallel with the first direction D1.

For example, a first variable holder **13\_1** holds the top side of the tested material TM and a second variable holder **13\_2** holds the bottom side that faces the top side.

The variable holder **13** may be a rectangle that extends in the first direction D1 along one side of the tested material TM. The variable holder **13** may be an insertion member having a U section that is shaped to hold the tested material TM.

In addition, the tested material TM may be inserted into the variable holder **13** and the top and bottom flanges of the variable holder **13** may be compressed to fix the tested material TM.

In another embodiment, the variable holder **13** may include compression flat plates like the above-described fixed holder **11**.

The variable holder **13** is formed of an elastic material or a ductile material having a holding region deformed in proportion to the deformation of the tested material TM. For example, the variable holder **13** may be formed of an elastic polymer material having high elongation and durability.

The size, shape, and structure of the variable holder **13** may be suitably varied. The variable holder **13** may be attached to and detached from the elongation tester **10** and may be exchanged as occasion demands.

Generally, when the tested material TM is elongated, a part of the tested material that is not provided with a holder to hold the tested material TM may be contracted. Thus, the shape of the tested material TM may be distorted. Such distortion of the shape may not realistically reflect a situation in which the outside of the electrode material is fixed by a frame when the flexible electrode material is actually applied to a product.

The elongation tester **10** according to the present embodiment includes the variable holder **13**. The variable holder **13** may entirely hold the outside of the tested material TM without affecting the elongation of the tested material TM, thus more realistically reflecting a situation in which the tested material TM is fixed by a frame.

Since the variable holder **13** is formed of the elastic material or the ductile material having the holding region deformed in proportion to the deformation of the tested material TM, the tested material TM may be easily deformed in the direction perpendicular to the elongation direction as well as in the elongation direction.

The wire lead **14** may be provided in the variable holder **13** in the longitudinal direction to reinforce and prevent the variable holder **13** from being bent in the direction perpendicular to the longitudinal direction. For example, when the elongation of the tested material TM in the first direction D1 is tested in the state where the variable holder **13** is mounted on the top/bottom sides of the tested material TM, the top and bottom sides of the tested material TM are easily extended in the first direction D1 (the elongation direction) by the variable holder **13** but may be prevented from being easily bent in the second direction D2 due to the wire lead **14** inserted into the variable holder **13**.

The wire lead **14** is preferably longer than the contracted variable holder **13**, considering that the variable holder **13** has a variable length. The length of the wire lead **14** is preferably the same as the length of the maximized (fully extended) variable holder **13** so that the wire lead **14** may cover one side of the tested material TM in the state where the variable holder **13** is deformed by the elongation test.

The driver **15** may drive the fixed holder **11** in a reciprocating motion. The reciprocating motion of the fixed holder

4

**11** (holding the tested material TM) means that the elongation test of the tested material TM is performed.

The driver **15** may be coupled to the fixed holder **11** through a coupling arm **16**.

A plurality of drivers **15** may be provided to correspond to the plurality of fixed holders **11**. For example, each of the plurality of drivers **15** may be coupled to a fixed holder **11**, such that reciprocation in different directions may be achieved. In an implementation, two drivers **15** may reciprocate in opposite directions that run parallel with each other.

When one fixed holder **11** is fixed to the supporting unit **17**, the driver **15** may make only the other fixed holder **11** reciprocate. For example, when the first fixed holder **11\_1** holds the left side of the tested material TM and the second fixed holder **11\_2** holds the right side of the tested material TM, the first fixed holder **11\_1** may be fixed to the supporting unit **17** and the driver **15** may drive only the coupled second fixed holder **11\_2** to reciprocate in the first direction D1 so that the elongation test may be performed.

The driver **15** may include a motor (not shown) for providing driving power and a gear (not shown) for mechanically transmitting driving power, and may further include various mechanical apparatuses in order to have the fixed holder **11** reciprocate.

A controller CNT may control the driver **15** to control the uniform speed and expansion range of the elongation.

The embodiments are not limited to a particular kind and shape of the driver **15**.

The supporting unit **17** may be a frame structure for fixing the elongation tester **10** to the bottom surface, and may support at least one of the fixed holder **11** and the variable holder **13**. For example, the fixed holder **11** and/or the variable holder **13** may be installed to move on the supporting unit **17**, or may be installed to be fixed and not to move.

The supporting unit **17** may further include a guide rail **18** for guiding the reciprocating motion of the fixed holder **11** and/or the variable holder **13**. For example, the fixed holder **11** and the variable holder **13** may be installed in the guide rail **18** that guides the elongation direction. For example, the fixed holder and/or the variable holder may include wheel-shaped structures.

In an implementation, the guide rail **18** may be provided to be adjacent to the top/bottom sides of the tested material TM in the first direction D1. The second fixed holder **11\_2** coupled to the driver **15** may precess and recess on the guide rail **18**, and the tested material TM may be expanded and contracted to perform elongation.

In an embodiment, the elongation tester **10** may further include a resistance measuring unit **19** for measuring a change in the resistance of the tested material TM and the controller CNT for controlling the driver **15**.

The resistance measuring unit may measure a resistance change, e.g., a change in electrical resistance, in accordance with the repeated expansion and contraction of the tested material TM. The elongation tester **10** may include various measuring units capable of detecting an electric characteristic value other than the resistance change.

As described above, according to the present embodiment, the variable holder **13** (formed of the elastic material and having the holding region deformed in the longitudinal direction of the outside in accordance with the deformation of the tested material TM) may be provided on the outside of the tested material TM in order to test the elongation while minimizing the distortion of the shape of the tested material TM.

FIGS. 2 and 3 are views schematically illustrating an elongation tester according to another embodiment.

5

The above-described disclosure may be referred to with respect to the elements denoted by the same reference numerals as those of the above-described elements; redundant descriptions of the elements may be omitted.

Referring to FIG. 2, an elongation tester 20 according to the present embodiment may expand/contract the tested material TM in the first direction D1 and the second direction D2 to test the elongation of the tested material TM.

In the embodiment shown in FIG. 2, four fixed holders 21\_1, 21\_2, 21\_3, and 21\_4 are mounted at the four edges or corners of the tested material TM. Four variable holders 23\_1, 23\_2, 23\_3, and 23\_4 are mounted on the four sides that form the outside of the tested material TM.

The four fixed holders 21\_1, 21\_2, 21\_3, and 21\_4 reciprocate in diagonal directions that form an angle of 45 degrees with the first direction D1 and the second direction D2. The tested material TM may be expanded and contracted in the four diagonal directions to perform elongation. Since the outside of the tested material TM is expanded, the four variable holders 23\_1, 23\_2, 23\_3, and 23\_4 are mounted on the four sides that form the outside of the tested material TM.

In the present embodiment, there are no fixed holders fixed to the supporting unit and all of the fixed holders 21\_1, 21\_2, 21\_3, and 21\_4 reciprocate.

Although not shown, a plurality of drivers may be provided to correspond to the plurality of fixed holders 21\_1, 21\_2, 21\_3, and 21\_4.

Guide rails 28 may be provided to be adjacent to the four edges of the tested material TM in the diagonal directions. The fixed holders 21\_1, 21\_2, 21\_3, and 21\_4 may precess and recess on the guide rails 28.

Wire leads, or rods, may be inserted into the variable holders 23\_1, 23\_2, 23\_3, and 23\_4 to prevent the variable holders from being bent in the longitudinal direction.

Referring to FIG. 3, an elongation tester 30 according to the present embodiment expands/contracts the tested material TM in the first direction D1, the second direction D2, and a diagonal direction between the first direction D1 and the second direction D2 to test the elongation of the tested material TM.

Here, four fixed holders 31\_1, 31\_2, 31\_3, and 31\_4 are mounted at the four edges of the tested material TM. The second, third, and fourth fixed holders 31\_2, 31\_3, and 31\_4 may be configured to reciprocate while the first fixed holder 31\_1 fixes an edge of the tested material TM not to move. In an implementation, the second to fourth fixed holders 31\_2, 31\_3, and 31\_4 may be configured to reciprocate in the first direction D1, the second direction D2, and the diagonal direction, respectively.

As described above in connection with previous example embodiments, a pair, or more, of fixed holders may reciprocate on the same axis in opposite directions. However, in the present embodiment, in the state where the first fixed holder 31\_1 is fixed, the second to fourth fixed holders radially reciprocate on three different axes in the first direction D1, the second direction D2, and the diagonal direction around the first fixed holder 31\_1.

Guide rails 38 may be provided in the three directions to guide the precession and recession of the second to fourth fixed holders 31\_2, 31\_3, and 31\_4.

Although the first fixed holder 31\_1 is fixed, since the outside of the tested material TM is expanded, variable holders 33\_1, 33\_2, 33\_3, and 33\_4 are mounted on the four sides that form the outside of the tested material TM.

Wire leads may be inserted into the variable holders 33\_1, 33\_2, 33\_3, and 33\_4 to prevent the variable holders from being bent in the longitudinal direction as described above.

6

By way of summation and review, a flexible electrode material may be tested as to elongation in accordance with repeated expansion and contraction of the flexible electrode material. In order to test elongation of the flexible electrode material, a passive method and a nonquantitative method may be used. For example, when the electrode is elongated in a short axis direction, the elongation of the electrode material may simply be measured as to the length to which the electrode may be expanded, without any measures to prevent contraction of the electrode material in the orthogonal axis direction of the elongation direction. When the electrode material is elongated, a part of the electrode material that does not have a holder may contract, so that the shape of the part may be distorted. The distortion of the shape may not realistically reflect the case in which the outside of the electrode material is fixed by a frame when the flexible electrode material is actually applied to a product.

Therefore, in testing the elongation of the flexible electrode material, a method of minimizing unnecessary distortion of the shape of the electrode material without affecting the elongation of the tested material to improve reliability of test is preferred.

As described above, embodiments relate to an elongation tester for grasping a characteristic in accordance with repeated expansion and contraction of a flexible electrode material. Embodiments may provide an elongation tester capable of testing elongation while minimizing distortion of the shape of a tested material. According to the embodiments, a variable holder (formed of an elastic material and having a holding region deformed in the longitudinal direction of the outside of a tested material in accordance with the deformation of the tested material) may be provided on the outside of the tested material, in order to test elongation while minimizing unnecessary distortion of the shape of the tested material without affecting the elongation of the tested material.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. In some instances, as would be apparent to one of ordinary skill in the art as of the filing of the present application, features, characteristics, and/or elements described in connection with a particular embodiment may be used singly or in combination with features, characteristics, and/or elements described in connection with other embodiments unless otherwise specifically indicated. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention as set forth in the following claims.

What is claimed is:

1. An elongation tester, comprising:

a fixed holder configured to hold an end of a tested material;

a variable holder configured to hold a side of the tested material, the variable holder being formed of an elastic material and having a holding region that deforms in a longitudinal direction of the side of the tested material in accordance with deformation of the tested material; and a driver configured to reciprocate the fixed holder.

2. The elongation tester as claimed in claim 1, wherein a wire lead is inserted into the variable holder in the longitudinal direction of the variable holder.

3. The elongation tester as claimed in claim 2, wherein the wire lead is longer than the variable holder.

4. The elongation tester as claimed in claim 1, wherein a plurality of variable holders is provided to surround a perimeter of the tested material.

5. The elongation tester as claimed in claim 1, further comprising a supporting unit including a guide rail for guiding a reciprocating motion of one or more of the fixed or variable holders.

6. The elongation tester as claimed in claim 5, wherein at least one of the fixed holder and the variable holder is supported by the supporting unit. 5

7. The elongation tester as claimed in claim 1, wherein the driver is configured to reciprocate the fixed holder in different directions. 10

8. The elongation tester as claimed in claim 1, further comprising:

a resistance measuring unit configured to measuring a change in resistance of the tested material; and  
a controller for controlling the driver. 15

9. The elongation tester as claimed in claim 1, wherein the variable holder is formed of an elastic polymer material.

10. The elongation tester as claimed in claim 1, wherein the tested material is a flexible electrode including at least one of a metal nanowire and a carbon nanotube. 20

11. The elongation tester as claimed in claim 1, wherein first and second fixed holders hold first and second portions of the tested material, and first and second variable holders hold third and fourth portions of the tested material, the first and second portions being opposite one another, and the third and fourth portions extending between the first and second portions. 25

\* \* \* \* \*